Delivery and Assessment Techniques for the subject "Integrated Design" in Civil Engineering

U. Johnson Alengaram*, Roslan Hashim and Lai Sai Hin

Department of Civil Engineering, Faculty of Engineering, University of Malaya, Kuala Lumpur, Malaysia, E-mail: ujohnrose@yahoo.com*

Abstract. New subjects are being introduced in Engineering on combining various issues that need immediate attention; recently, many universities introduced the subject known as Integrated Design for Civil Engineering students as a final year core course. The objective of this course to developing students' mind-set to understand the vital issue on sustainability; further integrating various aspects of design in civil engineering and infuse leadership & teamwork capabilities. This subject is quite different from other core subjects as every student is expected to conceive the conceptual design and develop the concept into a project through design by working in a group; the group is also expected to develop the whole project by addressing the sustainable issues in their project. Though it is group work based project, in addition to group assessment, evaluating every student on their achievement of the course outcome is mandatory to understand the students' capability. The academic staffs faces a difficult task in evaluating individuals and group on the conceptual design, design elements, sustainability issues, communication skill, team work, leadership capability, etc. As we started the course four years back, we adapted a methodology in evaluating the students on assessing various components of the subject. Over these years, we have modified the delivery and assessment technique and it proved to be effective in both the delivery of the subject and in assessment of the students both as an individual and group.

Keywords: Integrated design; sustainability; conceptual design; assessment method; team work; communication skills

INTRODUCTION

Integrated Design:- Recently this new course was introduced to final year Civil Engineering students in the Department of Civil Engineering, Faculty of Engineering, University of Malaya, Kuala Lumpur, Malaysia; in this context, it has to be mentioned that as one of the fifteen signatories to Washington Accord (WA), Malaysia is obliged to follow the agreement it signed to fulfil the academic requirements/attributes. The Washington Accord, signed in 1989, is an international agreement among bodies responsible for accrediting engineering degree programs. It recognizes the substantial equivalency of programs accredited by those bodies and recommends that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering. Hence, in order to fulfil the attributes of the outcome based education (OBE) which is obligatory as part of WA, the course outcomes of this course are meticulously planned and assessed.

COURSE MODULE AND OUTCOMES

The objective of this article is to explain the delivery and assessment methods for the course 'Integrated Design" that is being taught as final year core course for Civil Engineering students in University of Malaya. The course outcomes (CO) of the course are given below in Table 1.

Table 1. Course Learning Outcomes

No	Course Learning Outcomes (CO)
1	Design a Civil or environmental engineering project after going through different stages of conceptualizing and planning
2	Integrate information, ideas, and concepts from previous courses into a comprehensive design effort
3	Function effectively in a multidisciplinary team
4	Communicate effectively, in both oral and written forms

Table 2 shows the various programme outcomes (PO) expected for the whole degree programme; however, it is to be emphasised that not all the PO's could be achieved from one course or few courses. In fact each subject of the programme could address at least two or three PO's. Thus, fulfilling the requirement of CO's and PO's for one particular course has direct influence on the students' capabilities on understanding the subject, rather the broad view of the particular subject for which it was designed.

Table 2: Programme Outcomes (PO)

PO1	Apply knowledge of mathematics, science, and engineering
PO2	Design and conduct experiments, as well as to analyse and interpret data
PO3	***Identify the impact of engineering solutions in a global, economic, environmental, and societal context***
PO4	***Identify professional and ethical responsibility in Civil Engineering area***
PO5	***Communicate and function effectively as an individual and in a team with the capacity to be a leader***
PO6	***Identify, formulate and solve engineering problems in Civil Engineering area***
PO7	Recognize the need for information management and an ability to engage in life-long learning
PO8	Identify managerial and entrepreneurship skills
PO9	***Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, and sustainability***
PO10	Acquire technical competence, skills, and modern engineering tools necessary for engineering practice

As mentioned earlier, all the CO's are to be related to the few of the PO's for this course; Table 3 shows the correlation between the CO's and the PO's for the subject *"Integrated Design"*. CO1 has to deal with four of the PO's set out in Table 2 and similarly other CO's are related to the relevant PO's. As the students conceptualize and develop the project, they have to ensure that they address global, economical and societal context as set out in PO3; at the same time they have to address professional and ethical responsibility of civil engineering. By solving the problems they encounter and designing the project or component with sustainable, economic and social issues, they address the PO's 6 and 9. The evidence of addressing the relevant PO's has to be shown in the project.

Table 3. Correlation between Course and Programme Outcomes

Course Learning Outcomes (CO)	Programme Learning Outcomes (PO)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
Design a Civil or environmental engineering project after going through different stages of conceptualizing and planning			√	√		√			√	
Integrate information, ideas, and concepts from previous courses into a comprehensive design effort			√	√		√			√	
Function effectively in a multidisciplinary team				√	√	√				
Communicate effectively, in both oral and written forms				√	√					

In order to conceptualize the design project, one common design question will be given for all the group of students; normally the student groups are so divided into blend of students with high and low academic standings; since the Engineering Accreditation Council (EAC) norm stipulates each group with not more than 5, each group will consist of maximum of 5 students. The design project is so chosen such that it addresses all the CO and the students are expected to understand the CO and relate them to the respective PO. It should be noted that only relevant PO's for each course is addressed and evaluated by the assessors. For example, CO2 is on the integration of ideas and concepts from previous courses that the students had already learnt and putting those ideas/concepts into a comprehensive design project. However, the students should ensure that they address the PO's for that CO:

PO3/PO4/PO6/PO7. Thus, CO2 should address PO3 on identifying the impact of engineering solutions in a global, economic, environmental, and societal context. And in the same way, they should also address other relevant PO's.

COURSE DELIVERY METHODS

The course is not a formal taught course and the students are reminded to conceptualize the project based on the previous courses Learnt and at the same time utilize the latest resources from books and sustainability issues. As one of the important features of their understanding in this subject is sustainability issue, the students are exposed to the trend of various sustainable issues they have to address in their project. At least four lecturers from different specialization will be assigned to give informal lecture to address various CO's and PO's related to their area of specialization; the lecturers are also responsible for evaluating the students' project. Special lectures are given by practicing experts from the innovative areas such as green building index, design for sustainability etc. Further, site visits are arranged for the students to learn the practical aspects that are being implemented in the site.

Group discussions are encouraged between the members and each group is to submit the important points discussed during each group meeting through simple document for office record. Latest notes, information related to the project, forum, videos on the sustainable issues pertaining to the project are uploaded in the student learning website (Student Powered e-Collaboration Transforming UM-SPeCTRUM) specifically designed for the course. The various aspects of the course such as ethical, economical and contribution to society through the project are also discussed.

ASSESSMENT METHODS

The assessment of this course is one of the most important tasks; it isn't exam based subject, rather it is purely continuous assessment based system. Hence, the progress of every group and weekly reports on their work are monitored on continuous basis; the continuous assessment is done for the following project components:

- Progress of the project
- Group meeting regularity
- Weekly report

The other assessment includes peer review, communication skills etc. as shown in Table 4

Table 4. Assessment Components

Peer review (I)	Communication Skill & Technical Content (I)	Cont. Assessment (I)	Final Report (Individual) (I)	Conceptual Design & Mid Term Assesment (G)	Final presentation (G)	Final Report (G)

Generally, the individual assessment is done for the components as specified in Table 4; since each student is assigned certain tasks by the respective group leaders, the tasks completed by the individual students are reported by individuals and checked by the respective lecturers; if he does many tasks as required for the project, the students' contribution is recorded in the final report for individual contribution.

Assessment on Teamwork and Leadership –Peer Review

Teamwork and Leadership

Note:

1) You are to rank them in order from 1 to 4
2) Rank 1 is given for the highest grade and Rank 4 is for the lowest grade
3) You can't rank for yourself
4) You can't rank the same grade for more than 1 group mate

Write Your Name Here: _____ **Matrix No:** _____

Teamwork and Leadership Assessment
Group A1

No.	Matrix No.	Name	Teamwork	Leadership
1				

Signs of Good Leadership:

1. Leaders have initiative
2. Leaders take ownership
3. Leaders listen to others and seek advice
4. Leaders have an independent mind
5. Leaders are passionate and opinionated
6. Leaders recognize their limitations
7. Leaders share their knowledge

Signs of Good Teamwork:

1. Commitment to team success and shared goals
2. Interdependence
3. Interpersonal Skills
4. Open Communication and positive feedback
5. Commitment to team processes, leadership & accountability
6. Emotional support
7. Creativity and individuality
8. Solid Relationship

The individual assessment on the leadership and teamwork is done based on the rubrics as stated above; each student has to rank his or her peers and not allowed to rank themselves; at the same time they are not allowed to give the same ranking to fellow peers. This enables the lecturers to understand their involvement during the 14 weeks of cooperation and teamwork efforts on the part of the students.

Assessment on Final Report – Group

The assessment on final report is done on individual and group basis; since each member has to contribute to the project and report, their contribution and overall report is evaluated; each lecturer will evaluate the contribution if the particular aspect of the individual student's work lies in their specialization. Thus, both the contribution from the group work and individual efforts are considered in evaluation. In case of the student's individual efforts didn't fall in the lecturer's category, the onus lies with the coordinator of the course and he or she will be able to evaluate the contribution of the individual effort. The various aspects of the soft and hard skills as tabulated below are evaluated.

Group	Skills	Comments
	Soft Skills	a) Overall Layout and Structure:
		b) Quality of Graphics/Figures and Tables:
		c) Language:
	Hard Skills	a) Introduction/Concept/Solutions:
		b) Design (Structural/Geo-technical/Environmental/Construction Management/
		c) Costing and Bill of Quantities:
		d) Drawing, Manual Calculations etc.

Assessment on Communication Skills – Individual/Group

One of the most important aspects of civil engineer's attribute is communication skills; in fact we prepare the students from 1st year onwards to be effective communicators to convey their message to the audience, be it lecturers, contractors, senior engineers etc. The rubrics that we follow to assess the communication are tabulated below. The core values such as technical ability, sustainable issues, conceptual and commercial aspect of the project are evaluated during their presentation and also during the group's meeting on weekly basis. Thus each member will be asked questions pertaining to these issues based on their individual effort; another feature we incorporated in their evaluation is communication among the members during the course of their working together. Thus, every member

should be able to know what the other member is doing and the relevant points that link the whole project should be made known to other group members.

Rubrics on Assessment on Communication Skills – Individual/Group				
Very Poor	**Poor**	**Satisfactory**	**Good**	**Excellent**
1	**2**	**3**	**4**	**5**
Student - Mumbles - incorrectly pronounces terms - Speaks too quietly to hear	Student - Occasionally has eye contact - Voice is low - Incorrectly pronounces terms and difficult to hear	Student - Maintains eye contact most of the time - Voice is clear - Explanation is clear	Student - Maintains eye contact - Pronounces most words correctly - Makes his point clear	Student - Maintains eye contact - Uses a clear voice - Correct and precise pronunciation of terms - Makes point in short phrases

Conceptual Design and Mid-Term Assessment

After the formation of the group, the first phase of the students' work is to conceptualize the project incorporating various aspects of the design question. In fact we expect every student to use the right to disagree and constructively criticize others; this would enable the members not to impose the individual wills and desires on the group. Thus, the students must during their presentation show what are the arguments and disagreements they faced and how did they overcome as a group.

The conceptual design is then presented to the panel and also other groups to check their originality and innovation in their concept. The evaluation by individual lecturers from the panel is then compiled and used along with other components in their final evaluation of marks.

Another important aspect on monitoring the progress of the work is to check the continuous progress until week 7; hence the mid-term assessment plays an important role and in this monitoring assessment, each group will present their progress through short presentation in addition to show their course file. The course file should consist on the evidence of the work carried out during the course of 7 weeks of their design. Any changes made from the conceptual design based on the constructive criticism received during the initial conceptual presentation are shown; justification on the selection of the materials, concept, ideas etc. has to be presented during the meeting with the lecturers or during the mid-term assessment presentation.

Professional ethics and Washington Accord

It should be mentioned here that as a signatory to Washington Accord (WA) for engineering graduate students, Malaysia is obliged to follow the Engineering Accreditation Council (EAC), the body that monitors the WA's guideline in implementation of the academic programme based on the accord.

The Washington Accord Agreement recognises that:

> " Accreditation of engineering academic programs is a key foundation for the practice of engineering at the professional level in each of the countries or territories covered by the Accord."

Thus, it is the duty of the professional engineers to perform functions because of their knowledge, skills and attitudes. In this course of Integrated Design, we emphasise on the core values of WA and the benefits of Outcome Based Education (OBE). The programme Educational Objectives (PEO) of the Civil and Environmental Engineering Degree Programmes offered by the University of Malaya, Kuala Lumpur, Malaysia is unique and it incorporates diverse responsibilities as given below:

Thus the PEO's are designed to produce graduates who,

1. *Are competent professionals equipped with sound engineering knowledge for the well-being of mankind and in harmony with the environment?*
2. *Exhibit lifelong learning capability, aptitude and continual professional development.*

3. *Possess leadership, creativity and communication skills conducive to entrepreneurial awareness.*

The students are exposed to ethics of civil engineering graduates' and this course paves way to prepare them in conducive manner. We are also obliged to justify our role as models to infuse attributes of professional engineer in the minds of young engineering graduate students. Though this course is not a formal taught course as mentioned in the beginning, nonetheless, the lecturers play a significant role and have positive effect on the students' mental ability; at times, we remind them to understand the responsibility as future engineers and thus we bring them to understand the limitations and at the same time utilize the best possible means to achieve success and serve their fellow citizens with professional ethics and conduct.

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